Initiating and Preventing Fuel Fires in Composite Vehicles

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Abstract

The U.S. Army is in the process of constructing a Composite Armored Vehicle (CAV) as a demonstration project. It is expected that this vehicle will show advantages and disadvantages compared to the metallic (steel and aluminum) vehicles normally used. One of the areas of concern is how the use of composites in a vehicle affects its fuel fire survivability in a combat situation. This project was aimed at uncovering any important differences concerning the initiation of fuel fires when non-metallic fuel cells are used in non-metallic vehicles.

There has been a considerable amount of work on methods of protecting combat vehicles from fuel fires. The use of double-walled fuel cells and of powder packs has been shown to be adequate to protect metallic vehicles from sustained fires, given a hit on the fuel cell. Non-metallic (polyethylene, nylon and fiberglass) fuel cells are currently used, but in metallic combat vehicles. In this task, non-metallic fuel cells were used in simulated composite vehicles. Shaped charge jets were fired through composite armor into the fuel cells, through the liquid fuel.

When a shaped charge jet passes through a fuel cell, a cloud of fuel vapors and droplets exit the cell through the holes made by the jet. It is believed that the hot spall particles produced when the jet perforates the skin (armor) of the vehicle are the ignition sources for the fuel spray. It is not obvious that composite materials will produce a sufficient number of hot spall particles to act as reliable ignition sources. It is possible that there will be a less severe fuel fire problem in a CAV than in metallic vehicles. Rockeye shaped charge devices were detonated against sheets of both non-metallic and metallic materials. It was found that fewer burning spall particles were produced from the non-metals.

Shaped charge jets were then used to attack non-metallic fuel cells in a simulated composite vehicle. Indeed, it was found that spall from the kevlar and polyethylene did not act as a good ignition source. However, fire was still possible, due to the fireball from the shaped charge device acting as an ignition source for the hot JP-8 fuel.

It was observed that the sides of the non-metallic fuel cells failed in a different manner that metallic sides fail, when jets transversed the fuel cells. The non-metallic entrance and exit sides tended to crack, in situations where metallic sides would just petal open. The cracking of the sides allowed massive

fuel leaks to occur. This enhanced the possibility of sustained fuel fires.

Honeycomb powder packs with non-metallic faces also reacted in a different manner than powder packs with aluminum foil faces. The aluminum foil faces failed catastrophically, releasing large quantities of fire extinguishing powders. The kevlar faces of the non-metallic packs cracked, releasing a small amount of powder from the honeycomb. This was a negative for fire protection. Polyethylene faces did not perform any better than the kevlar.

Work is continuing utilizing a second generation powder pack which is a pressurized plastic container of gelled fire extinguishing powder. It will be used with non-metallic cells under shaped charge jet conditions and under pool fire conditions.